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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Railroad Diesel Lubrication

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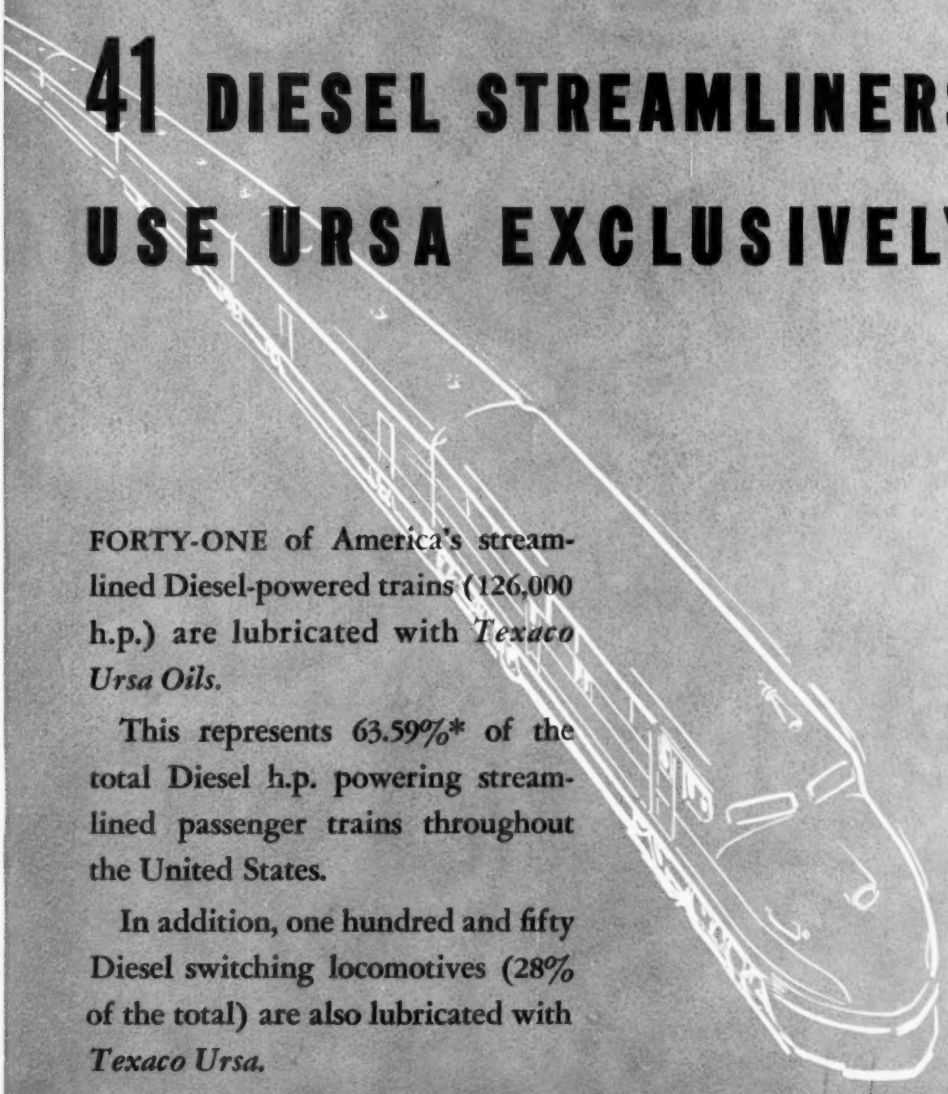
41 DIESEL STREAMLINERS USE URSA EXCLUSIVELY



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* *Figures of June 1, 1940*

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FOR DIESEL LUBRICATION

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Railroad Diesel Lubrication

THIS article is devoted to a study of the lubricating oil requirements of the popular light weight engines which the Diesel industry has provided to meet the demand of the railroads for main line as well as switching service and which have these general characteristics:

Horsepower	500— 1500
R.P.M.	600— 900
Cylinder Bore	8″— 13″
Piston Stroke	10″— 16″

These railroad Diesels were originated by Ingersoll-Rand and Westinghouse while engines of this type, now in service, are being built by American Locomotive, Baldwin, Cooper-Bessemer, Electro-Motive, Fairbanks-Morse, and General Machinery. Busch-Sulzer has somewhat larger railroad Diesels, while the smaller automotive type engines as built by Buda, Caterpillar, Cummins, Waukesha and others have been adapted to railroad locomotive service.

Two of the principal advantages claimed for the Diesel in railroad service are lower operating costs and greater availability. Therefore, the lubricating system and the lubricants used must provide not only reliable, but also economical lubrication. This has been attained and in some cases lubrication records have been established which even surpass the performance of the Diesel in stationary service. When the differences in engine design and type of service are considered the fact that the railroad type compares favorably with the stationary is quite remarkable.

Railroad Diesel requirements are more severe than stationary for several reasons. The average stationary engine operates in fairly narrow load, speed and temperature ranges, while the railroad Diesel frequently idles for comparatively long periods immediately followed by accelerating runs with heavy loads. Because of weight and space limitations, the railroad Diesel is more compact, runs at higher speeds, has smaller oil reservoirs and operates at higher temperatures.

Due to the great importance of good lubrication, railroad Diesels are equipped with well designed lubricating oil systems. In a representative engine, the path of the oil follows this general course: From a separate oil tank, a gear type oil pump forces oil past an oil pressure relief valve and a pressure gauge to the main bearings. From the main bearings the oil passes through a drilled crankshaft to the crankpin bearings, thence through drilled connecting rods to the wrist pin bearings. Oil from the wrist pin is used for piston cooling. Cylinder walls are lubricated by splash from the crankpin bearings while accessories take oil from the main bearing oil header. Most of the oil from these various points drains into the engine crankcase which is kept "dry" by a scavenger pump, forcing the oil through a filter and cooler and thence back to the external oil tank.

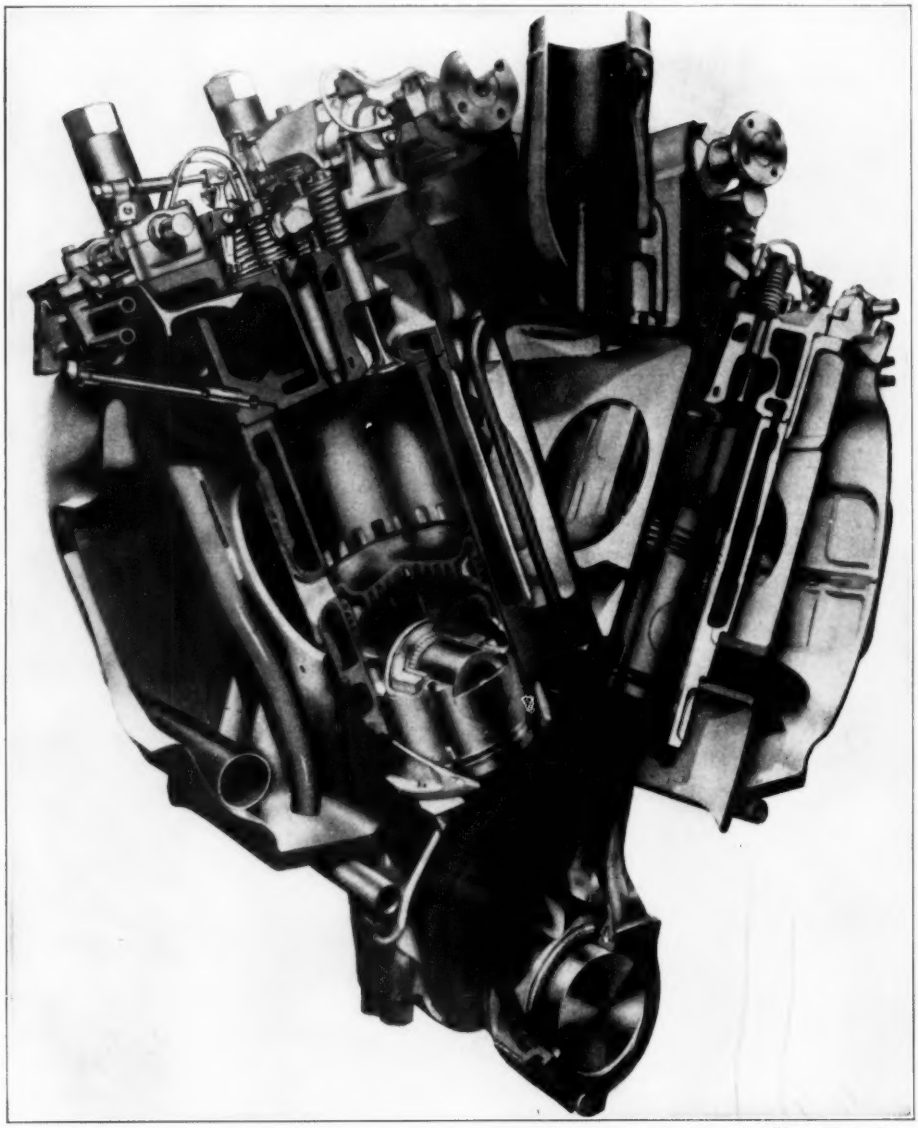
The railroads, to assure dependable service have developed the system of preventive maintenance to a high degree. The engines are kept in excellent operating condition at all times, the lubrication system receiving its

deserved share of attention. By means of carefully kept records of long standing, the expected life of any given part is fairly well known and accordingly, liners, bearings, rings, etc., are replaced before, rather than after they have failed, thus reducing service breakdowns to

subjected to the same rigorous preventive maintenance practice.

Bearings

Rather high B.M.E.P. and R.P.M. combine with a fairly large shaft diameter to give the



Courtesy of Electro-Motive Corp.

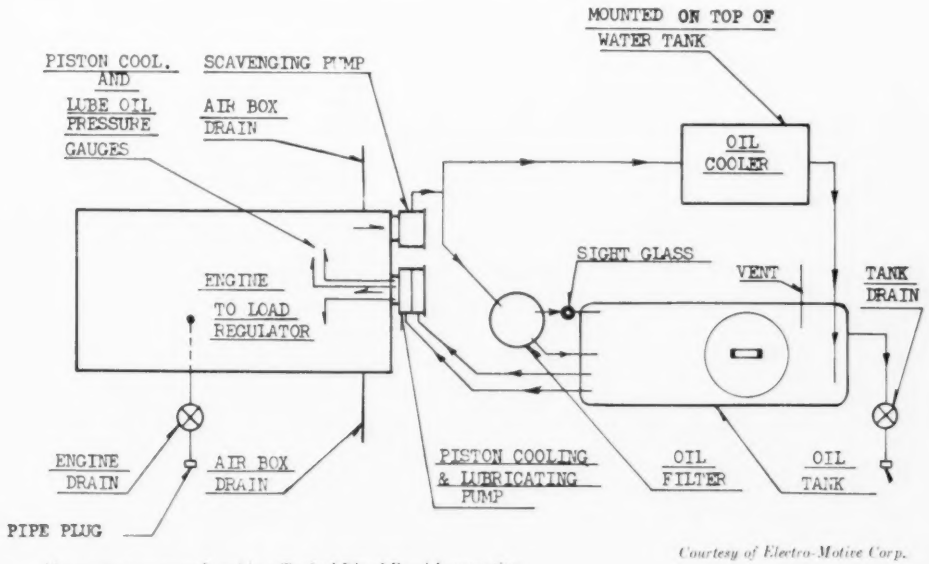
Fig. 1—General Motors Two Cycle Diesel Engine for Railway Equipment.

exceptionally low figures. Such parts are often replaced between 100,000 and 200,000 miles of operation although in many cases much longer life is indicated. Oil is considered just as much an engine part as anything else and is inspected, serviced, replaced and otherwise

main and connecting rod bearing surfaces a high velocity-load factor requiring heavy duty bearing materials. High grade babbitt has proven satisfactory in some engines while others use hardened lead or copper-lead bearings. In almost all cases the bearing metal

contains some tin which seems to rather effectively prevent oil corrosion. The absence of corrosion difficulties is best explained by low temperature of the oil in the bearings which is well below the 275 degrees Fahr., temperature usually considered critical. Regardless of the freedom from oil corrosion which exists in these engines, where special bearing metals are employed, non-corrosive oil should be used.

Difficulties due to improper oil viscosity seldom occur since water and oil temperatures are rather carefully controlled although the method of control is often manual and occasionally neglected. It is merely necessary to provide an oil having the proper viscosity at the operating temperature—usually around 160 degrees Fahr.



Courtesy of Electro-Motive Corp.

Fig. 2—Arrangement found in a Typical Diesel Road Locomotive.

New oil as placed in an engine is not corrosive but all oils oxidize to some extent, depending on the severity of the operating conditions. The oxidation products of some oils are corrosive; therefore, if the bearings are of a type which are subject to corrosion, it is advisable to use either a straight mineral oil which is naturally non-corrosive or which has been made non-corrosive by the addition of a corrosion-preventing compound. With the latter type of oil in use, consideration must be given to the fact that in some cases the additives are removed by filtration or become ineffective after extended use. In this connection oils are available which prevent engine corrosion and bearing deterioration originating from other sources. Thus the modern oil film not only lubricates and cools but also protects engine surfaces.

With certain types of bearing metal spotty deterioration or crumbling of the metal frequently occurs. It is not known definitely whether this is due to fatigue or erosion, but it is not a form of oil corrosion; although there is the possibility that oils may protect against this deterioration.

The oil is ordinarily not left in service long enough to increase in viscosity due to oxidation but in some designs a rapid drop in viscosity can occur due to fuel dilution. The effect of dilution on viscosity is about as follows for an S.A.E. 40 Oil and a No. 2 Fuel Oil:

Dilution	*Viscosity at 160 °F., Sec. and equivalent S.A.E. No.*
0%	130 (S.A.E. 40)
5%	100 (S.A.E. 30)
10%	85 (S.A.E. 20)
20%	70 (S.A.E. 10)

Wrist pin bearings must withstand rather high temperatures and high loads but only a relatively slow oscillating motion. Plain bronze bearings with a high percentage of copper or roller bearings of the needle type are used to meet these conditions. These bearings being on the "end of the line" are most apt to suffer from insufficient lubrication due to lack of oil pressure. This might be encountered at slow speed, with too light an oil, and excessive bearing clearances.

Although the usual function of a lubricant is to prevent wear, in railroad Diesels bearing failures are ordinarily due to fatigue, conse-

quently, from a lubrication standpoint, the primary consideration is maximum cooling effect since fatigue resistance of bearing metals is improved at lower temperatures. To provide the desired cooling effect, oil pumps are of large capacity; ample flow of lubricant is assured by sufficiently large oil lines, bearing clearances and grooving, while efficient oil coolers are installed to maintain a reasonably low oil temperature.

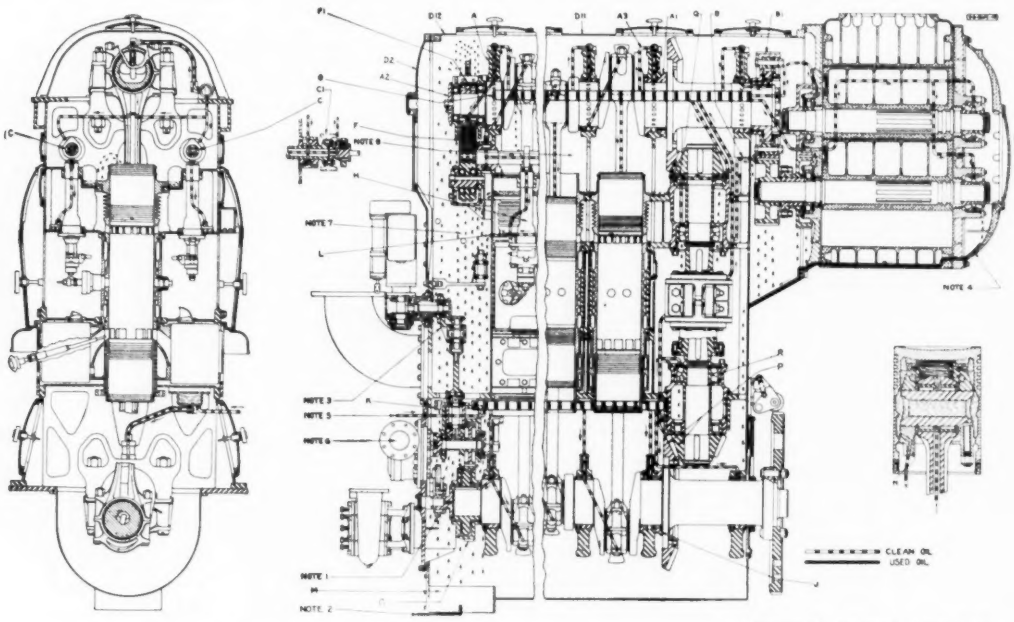


Fig. 3—Fairbanks-Morse 38 D-8 Diesel Lubricating Oil System.

Courtesy of Fairbanks, Morse & Co.

Since these engines operate at fairly high speeds, when determining the size of the oil flow passages to and from a bearing, care must be taken to make sure that the amount of oil supplied by the pump to the bearing is greater than the quantity of oil thrown out of the oil exit passage by centrifugal force.

Carbonaceous Deposits

As in any discussion of internal combustion engine lubrication, it is necessary to suspend factual description and theorize on the source and mechanism of the formation of carbonaceous engine deposits. The word "theorize" must be used, since, owing to the nature and complexity of the chemical compounds involved, the chemist is unable to definitely determine the origin of such deposits by laboratory analyses. Fortunately, by studying thousands of analyses and comparing the findings with actual service results, certain general conclusions have been reached.

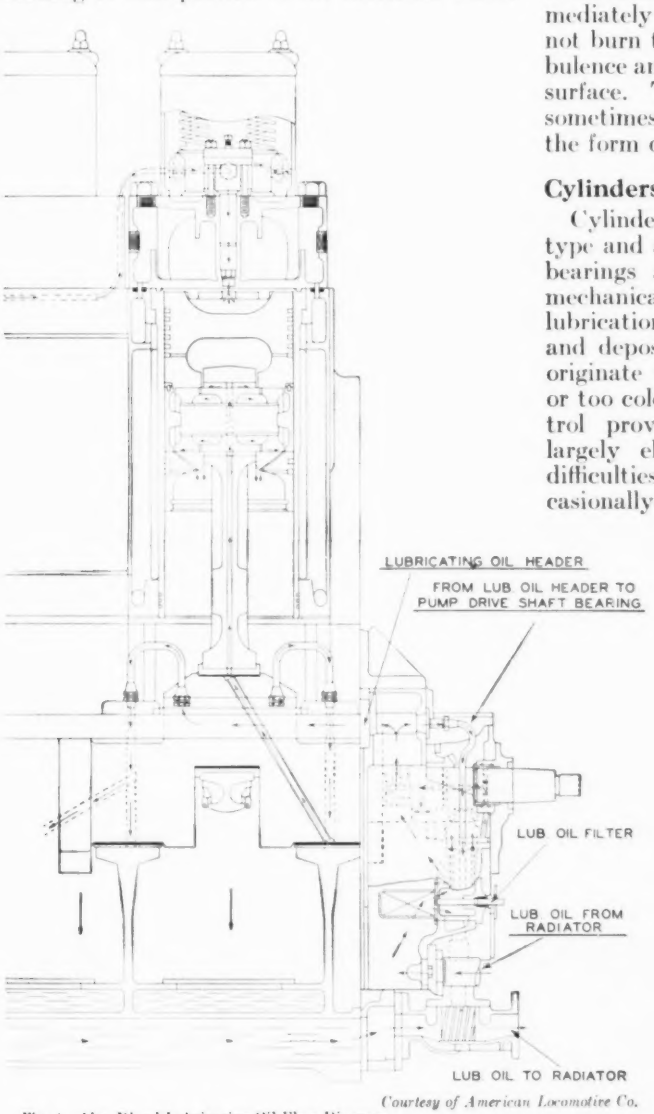
Petroleum, when exposed to high temperature, forms carbonaceous solids of three general types, viz.: free carbon—C, heavy hydrocarbons —CH, and oxidized hydrocarbons—CHO. The laboratory can differentiate between these three types of solids and thus provide a clue as to the mechanism of their production.

Free carbon is a by-product of the combustion process where all the carbon freed by the destruction of the fuel or lubricant does not burn to CO_2. Free carbon can also result from the cracking of the fuel or lubricant when exposed to high temperatures (over 600 degrees Fahr.). While the chief function of the cracking process is the breaking up of larger molecules into lighter hydrocarbons, heavier liquids often of a tarry nature and some free carbon are formed as by-products. On the other hand, when lubricating oil is exposed to medium temperatures (under 400 degrees Fahr.), as in laboratory oxidation tests, ordinarily little, if any, free carbon is formed.

When oxygen unites with a hydrocarbon a sludge-like product may be formed. Appreciable oxidation of hydrocarbons occurs at temperatures over 150 degrees Fahr., but proceeds more rapidly at higher temperatures (above 250 degrees Fahr.). The first oxidation products formed are soluble in the oil; however, as oxidation continues, heavier insoluble products are formed.

A high percentage of free carbon usually indicates that the carbonaceous material originated from fuel soot due to incomplete combus-

tion. This is substantiated by the higher free carbon content of used Diesel oils compared to that of used gasoline engine oils. In gas engine oils, the free carbon content is even lower. Free carbon can, of course, result from the burning of that portion of the lubricant which is exposed to combustion gases or to the exposure of oil to the high temperature of a hot surface such as the underside of the piston.


LUBRICATING OIL HEADER
FROM LUB. OIL HEADER TO PUMP DRIVE SHAFT BEARING
LUB. OIL FILTER
LUB. OIL FROM RADIATOR
LUB. OIL TO RADIATOR

Courtesy of American Locomotive Co.

Fig. 4—Alco Diesel Lubricating Oil Flow Diagram.

Where distillate fuels are used products of combustion will usually be of the free carbon type. Heavy fuels on the other hand, do not entirely gasify in the combustion chamber and the heavy ends may crack and oxidize to tarry-like deposits. In the railroad Diesels, fuels used are ordinarily distillates and, therefore, petroleum oxidation products found in the engine are generally classed as originating from lubricating oil, although there are many exceptions to this generalization. Liquid fuels can oxidize in fuel injection systems and cause gum formation. That portion of the fuel gases, immediately adjacent to the cylinder walls, does not burn to completion due to the lack of turbulence and the close proximity of a well cooled surface. The resultant oxidation products are sometimes deposited on the cylinder walls in the form of a hard varnish.

Cylinders

Cylinder liners usually are of the removable type and are lubricated by splash from engine bearings and piston cooling oil or separate mechanical lubrication. Efficient cylinder lubrication keeps down cylinder wear, scoring and deposits. Since such cylinder difficulties originate when cylinder walls become too hot or too cold, the water jacket temperature control provided by most manufacturers has largely eliminated any cylinder lubrication difficulties. Trouble, of course, occurs occasionally due to insufficient cooling, faulty injection, water leakage or improper attention to air cleaners, but in general the cylinder lubrication design has been well handled.

In two cycle engines, when the exhaust is through a mechanically operated valve, good lubrication of this valve is important since sluggish action cannot be tolerated. Valve stem deposits to a large extent depend upon valve stem temperature, which, in turn, is partly governed by the exhaust temperature. Engine adjustments control the exhaust temperature. Minimum exhaust valve deposits are also dependent on the proper quality and quantity of oil reaching the valve stems.

In two cycle engines, where the exhaust is through open ports uncovered by the movement of the piston port, deposits are also limited by exhaust temperature and rate of oil feed. Only sufficient oil to lubricate the cylinders should be supplied. If the total engine oil consumption is much greater than 2500 H. P. hrs./gal. the excess oil will reach the exhaust ports causing carbonization. In two cycle engines a fairly large amount of cylinder lubricant is scraped into the intake ports and is carried into the cylinder with the intake air. Two cycle engines are, therefore, designed so that this oil from the intake ports is

not blown directly across the cylinder and out the exhaust ports. Due to local conditions, however, such as high exhaust back pressure, cylinder lubricant is occasionally wasted in this manner and may even be found deposited in considerable quantity on the inside walls of the exhaust manifold directly opposite the exhaust ports. Wet exhaust ports collect soot, the amount being dependent on the extent of afterburning of the fuel, thus proper control of combustion timing is essential for the satisfactory operation of railroad Diesels.

Late burning of the fuel is not always evidenced by exhaust smoke, but is usually indicated by lower combustion pressures and higher exhaust temperatures. Control of exhaust temperature and the maintenance of a uniform load throughout all cylinders is obtained by frequent routine checks on injection timing.

Pistons

Railroad Diesel pistons are made from alloys of aluminum or cast iron, but from the lubrication standpoint the principal interest is not in piston material but in piston clearance which affects scoring tendency and oil consumption. Insufficient clearance may result in piston or cylinder scoring for under heavy load the piston runs at a higher temperature than the cylinders and consequently expands more. Too much skirt clearance causes high oil consumption—G. C. Williams in "Collected Researches on Cylinder Wear," January 1940, reports the following relationship:

Piston Material	*Skirt Clearance*	*Oil Consumption Pts./Hr.*
Cast Iron	.003	.019
Aluminum	.007	.045

Many of the railroad Diesels have piston diameters in the neighborhood of ten inches; the figure that has been mentioned as the maximum diameter permissible for aluminum pistons due to the greater piston clearance necessary to take care of expansion. Although aluminum pistons having low expansion characteristics are available, they usually have a skirt clearance of .002″/inch diameter while cast iron piston clearances are about .001″/inch diameter.

Owing to the relatively high speeds at which

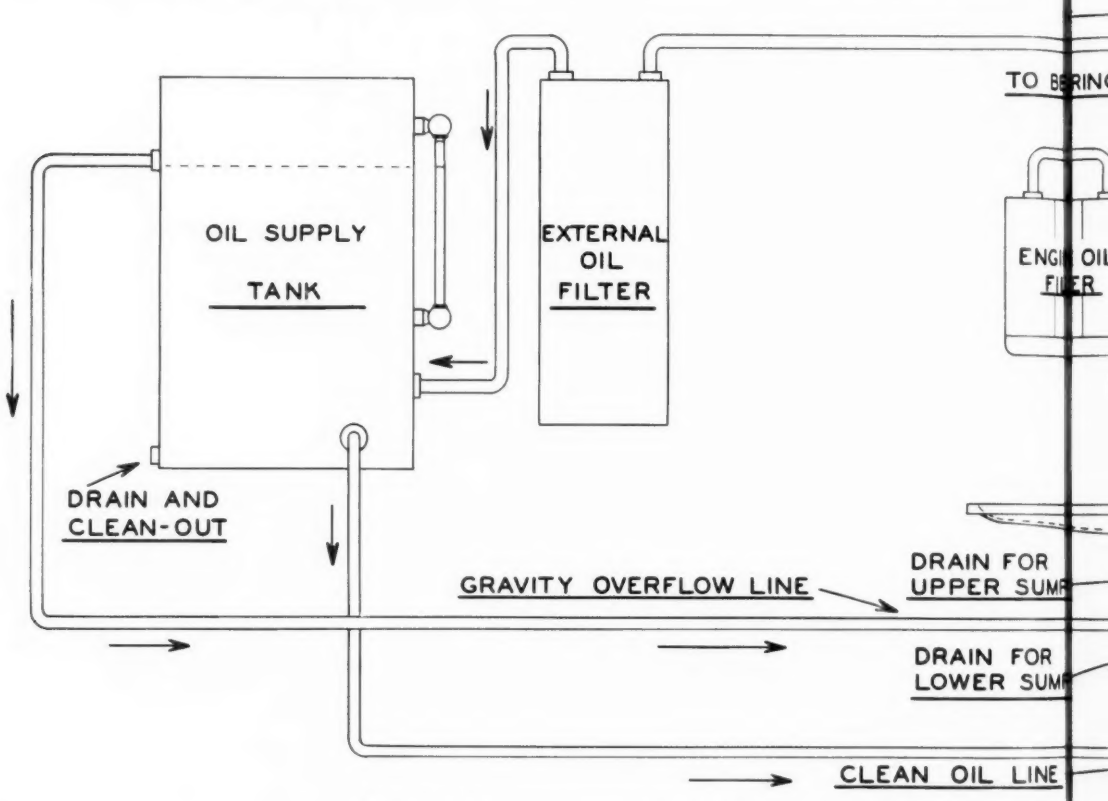
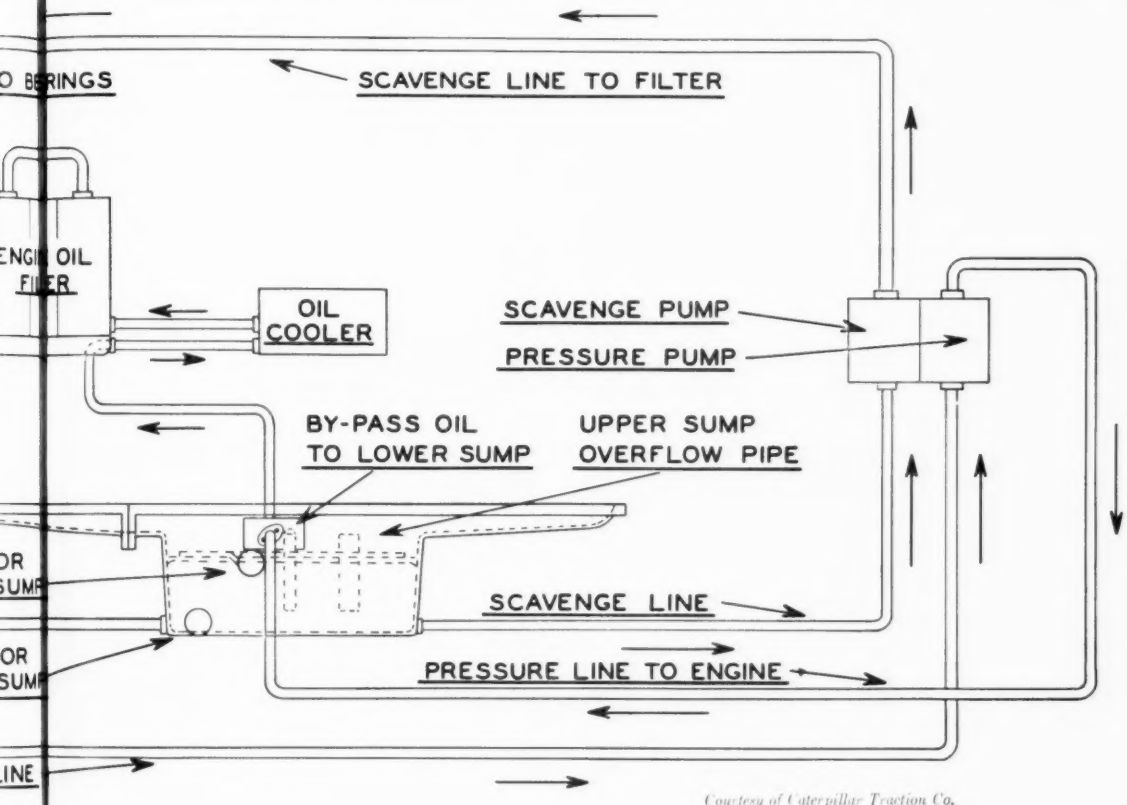


Fig. 5—Caterpillar D-17000 Locomotive Diesel Triplex Lubrication System.

these engines operate, greater care must be taken to guard against high oil consumption; hence, piston clearances are held fairly low and, to guard against scoring difficulties, means are provided to keep the lubricating oil free from abrasives of any kind. In some cases, ing tube in the piston when the piston is at the bottom of the stroke.

Although at first hand, using the lubricating oil as a piston cooling medium would seem to impose an added load on the lubricant, actual service results show that better general lubri-



Courtesy of Caterpillar Traction Co.

for the same reason, pistons are plated with metals having good anti-friction qualities.

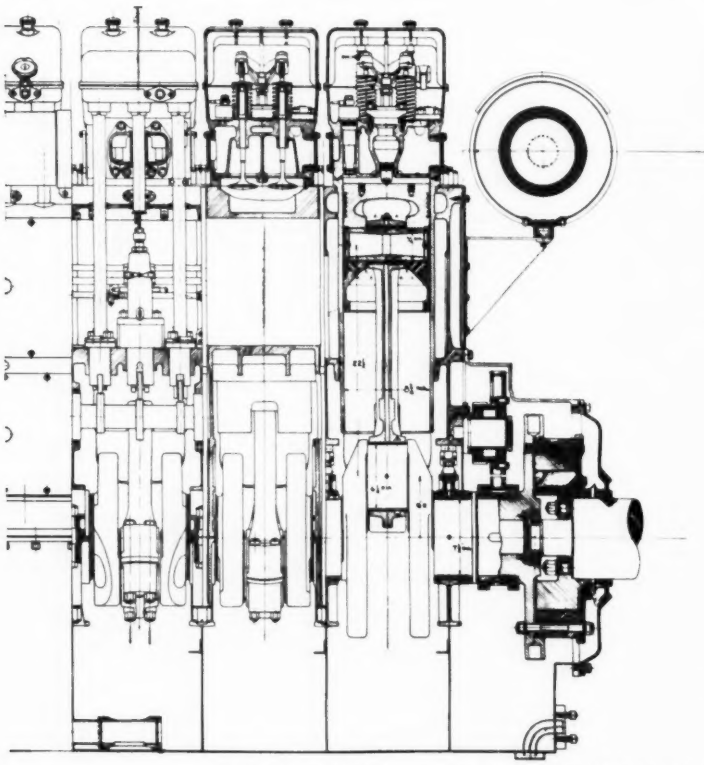
To reduce ring sticking and other difficulties resulting from the transfer of too much heat through the top piston ring, some pistons are designed with considerable metal in the head to provide a direct path for the heat to pass to the lower rings, thus lightening the heat transfer load that would otherwise have to be carried by the top ring. Other pistons are designed with a comparatively thin piston crown, so constructed that a minimum quantity of heat will reach the rings; at the same time, oil cooling is provided to remove the heat absorbed by the piston. Piston oil cooling is effected in some engines by direct spray from the top of the connecting rod to the underside of the piston crown. Others provide internal oil cooling; the oil reaching the piston cooling passages either from the connecting rod or by means of a stationary tube which connects with a matchcation is secured where pistons are oil cooled.

It is better to have the general oil temperature run a little high due to the heat absorbed from the piston, provided maximum surface temperatures are reduced. The advantages of a low general oil temperature are lost if some of the oil splashes against the very hot underside of an uncooled piston. In other words, it is the maximum temperature to which part of the oil is subjected that is important, rather than the average temperature of the oil in the system. At high temperatures free carbon as well as oxidation products are produced, especially where the oil is exposed in a thin film. It is rather common practice to provide a baffle plate underneath the piston crown to prevent this. These oxidation products which are formed at high temperatures are often soluble in very hot oil so that deposits do not always collect on the hot surface, but are precipitated upon cooler running parts.

Piston Rings

As long as the proper type of lubricant is used, piston ring lubrication is not proving difficult in engines of latest design, although some older models have presented ring sticking problems. There also seems to be little of the high temperature ring wear which is sometimes encountered in Diesels of larger cylinder diameter, having a lower cylinder surface-volume ratio. This is important from the heat conductivity viewpoint. The greater piston clearances found in certain larger engines may account for some of the ring wear experienced in certain big stationary Diesels since Mr. Williams also reports:

Piston Skirt Clearance	*Top Ring Wear Inches Per 1000 Miles*
.005	.00010
.015	.00034
.025	.00057



Courtesy of General Machinery Corp., Hooven, Owens, Rentschler Div.

Fig. 6—Hamilton Four Cycle Diesel.

Generally speaking, however, the severity of service of railroad Diesels lies in between that of the slow speed stationary and the high speed automotive type Diesel. This is made clear by the results of an analysis of three groups of Diesels representative of each type of service. Each group included two-cycle, four-cycle unsupercharged and four-cycle supercharged Diesels which combine to give the following average figures:

	Stationary	*Railroad*	*Automotive*
Number Engines	10	6	5
H.P./Cylinder	164	93	24
R.P.M.	306	790	1920
B.M.E.P.	71	84	97
Cylinder Area □″/H.P.	7.3	4.0	3.4
Weight, Lbs./H.P.	99	33	13
Piston Speed	1107	1505	1630

It is apparent from this summary that, from a ring lubrication standpoint, the railroad Diesel represents neither the easiest nor the worst condition encountered.

In some types of heavy duty road engine service, where reliability is the paramount consideration, rings are checked and replaced if necessary at 100,000 miles or 2,000 hours whereas in switcher service ring replacements are frequently not made until 16,000 hours. Preventive maintenance requires close and frequent ring inspection, since worn or sticking rings cause blowby which rapidly burns off the cylinder lubricant with ultimate piston seizure and engine stoppage—a possibility that cannot even be considered in road service.

The freedom from ring sticking existing in railroad Diesel service is by no means accidental. Piston ring temperatures are kept low by properly designed pistons; injectors are frequently checked insuring good combustion; cooling water is properly treated to prevent scale formation; lubricants possessing good anti-ring sticking qualities are used by the majority of railroads; lubricating oil is kept clean; distillate fuels of high cetane number are in general use, cylinders are carefully designed to prevent distortion and good oil control is provided by efficient oil rings, preventing an excess quantity of oil from reaching the compression rings. In this connection the use of two oil control rings is almost universal. In two

cycle engines the oil rings are at the base of the piston skirt to prevent escape of oil into ports, while in four cycle engines the oil rings are usually located above the piston pin.

Oil Filtration

Oil filters are ordinarily not of the full flow type but when new have a capacity around 20% of the oil pump capacity. Oil coolers on the other hand are of greater capacity, consequently the ideal arrangement is to install the oil filter ahead of, and in series with, the oil cooler with both the filter bypass and filter discharge lines leading to the oil cooler.

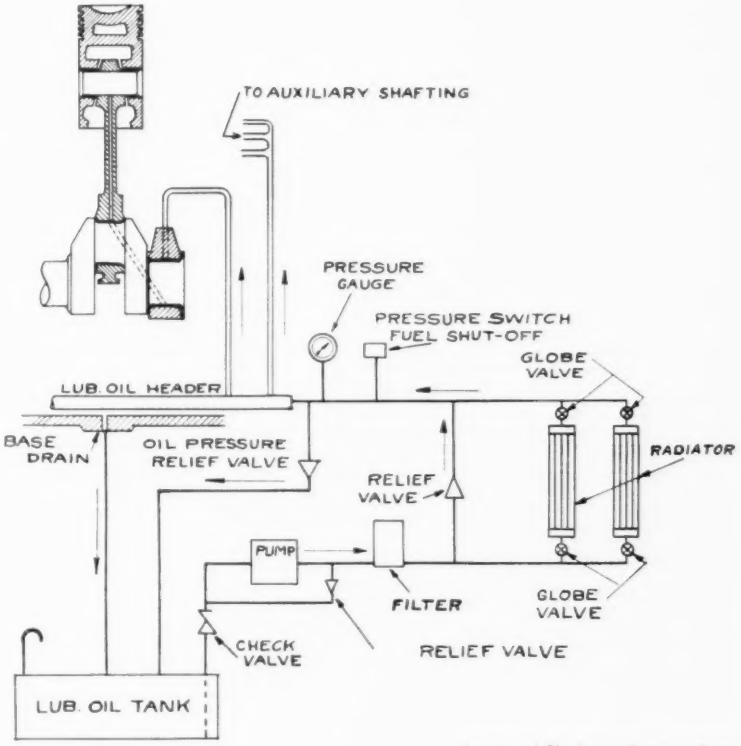
A variety of oil filter makes are used including metallic, cloth, waste, edge and clay types. Fortunately, oils containing additives which are removed by efficient filters have not, as yet, proven desirable in railroad Diesels, therefore, the question of additive removal does not enter into the selection of a filter and efficient filters of large capacity are in general use.

Oil Coolers

Oil coolers are generally of the radiator type although the tube types are also used. Large capacity oil coolers are a necessity: First, to provide a fairly constant oil temperature under the variable load and speed condition encountered. Second, because the small oil system capacity results in the absorption of the engine heat by a comparatively few gallons of oil; the ratio of H. P. to oil system capacity is as low as 10 to 1 in railroad Diesels against about 4 to 1 in well designed stationary Diesels located where space is more or less unlimited. Third, because the oil is often used for piston cooling. Fourth, because a reasonable low oil temperature increases bearing resistance to fatigue, reduces oil oxidation and reduces oil consumption.

Oil Tanks

Because of height limitations it is not feasible to carry much oil in the engine crankcase, therefore, scavenger pumps are usually furnished to carry the oil to a separate tank located away from the engine. This arrangement has the advantage that it keeps the oil away from hot gases and heat. There is usually not much extra space available for the lubricating oil tank which, as a result, is rather small. Low oil capacity results in a greater concentration of solids as well as increased oil temperature. These disadvantages are overcome by the installation of oil filters and coolers.



Courtesy of The Cooper-Bessemer Corp.

Fig. 7—Cooper-Bessemer Locomotive Engine Lubrication System.

The crankcase scavenger pump, in order to insure a "dry" crankcase usually has an excess capacity of about 30% and as a result pumps a considerable quantity of air through filter and cooler to the oil tank. Care must accordingly be taken, in the design of the oil system, to guard against foaming. To prevent foaming in the oil tank the surface area should be as large as practical to allow the air the maximum opportunity to escape from the oil. Therefore, the oil tank should, if possible, be shallow rather than high. While a tall tank conserves floor space it may fail to provide sufficient surface area to prevent foaming. In any event about 30% additional height above the oil level should be provided so that, in case foaming occurs, the foam will not overflow. Oil filters and coolers are pretty good air separators and

these should be vented, not only to prevent their becoming air bound, but also to remove air from the oil. Such vents should be in the form of a continuous running small stream of oil flowing in a separate line to the oil tank.

Not a great deal is known as to the oil characteristics which effect foaming. Heavy oil foams more than light, cold oil more than hot, and new oil more than used oil.

Oil Reclaiming

Many railroads operating large numbers of Diesel locomotives, have installed in their shops batch type oil purifying systems to extend the life of the oil, thereby reducing operating costs. The economic aspect is, of course, the first factor which should be considered when contemplating the installation of such a system.

If oil reclaiming can be done economically, then consideration can be given to the effect of reclaimed oil on engine lubrication. Reclaimers work to their best advantage when used in connection with Diesels in which the lubricating oil becomes contaminated at a much faster rate than the oil filters can remove the impurities. There is no question but that keeping the oil clean by frequent reclaiming is better than allowing the engine to run on dirty oil. On the other hand, other factors should be taken into account if filters do keep the oil in a reasonably clean condition and engine operation is such that long drain periods are possible.

In such cases the advantages of putting fresh new oil in the system may outweigh the economic value of reclaiming the distillate oils which are used by most railroads. Carefully conducted laboratory tests show, by vacuum distillation and other means of analysis, that even the best methods of reclaiming distillate lubricants leave in the oil both heavier and lighter liquid hydrocarbons than are in the original new oil. In refinery parlance reclaimed oil is thus equivalent to a broader distillation cut. The lighter ends present in reclaimed oil presumably originate from the fuel. This dilution is to some extent removed by subjecting the oil to around 400 degrees Fahr., in the reclaiming process; however, to remove all this dilution and bring the oil back to its original viscosity has in some cases required temperatures over 600 degrees Fahr., even under vacuum. This is obvious since the distillation range of Diesel fuels lies between 300 degrees and 700 degrees Fahr. Heating the oil above its flash point of about 400 degrees Fahr., is of course practical but is somewhat dangerous. If much fuel dilution occurs on a particular engine a complete change to new oil is recommended unless the operator wishes to make viscosity determinations locally and use heavier grades of new oil to blend with the reclaimed oil to correct the viscosity as necessary.

The so called heavy ends which are revealed in reclaimed oil, by vacuum distillation in the laboratory, may increase carbon deposits in an engine.

Laboratory oxidation tests show that new oil is more stable and more resistant to chemical change than reclaimed oil. This is believed due to the established facts: First, that reclaiming does not remove all the soluble oxidation and polymerization products formed in an oil in service. Second, that these partially oxidized oil molecules are more susceptible to further oxidation at a faster rate than the constituents of new oil.

Many oils depend on additives for their better characteristics; reclaiming not only removes such additives but also may remove certain beneficial substances naturally present in new oil.

The performance differences between well reclaimed oil and new oil are admittedly small in some cases; however, in certain critical engines the discrepancy may be the difference between successful operation and engine failure.

It is not the purpose of this article to belittle the fact that many engines can be and are operated successfully on reclaimed oil to the all-around benefit of the engine; but it is our intention to point out that there are also installations where the periodic changing to a new oil is more desirable.

Oil Drain Periods

The preventive maintenance policy in force on most railroads requires that the oil be drained at sufficiently frequent intervals so that no mechanical difficulties will occur which could be attributed to dirty oil.

Oil must be drained when it becomes contaminated by any of the following: fuel soot, liquid fuel, water, metal from excessive wear, rust, or oil decomposition products resulting from oxidation or high temperature.

Of these, the average filter does not remove liquid fuel or water nor all of the fuel and oil decomposition products.

The presence of fuel dilution and water can be detected by rather simple means; the amount of petroleum decomposition products, however, can only be measured in the laboratory. Many railroads take advantage of the lubrication service rendered by some of the oil companies who by examination of the oil and by previous experience on similar equipment, can determine if the oil is satisfactory for continued use. In no case, however, should drain periods be extended beyond the interval set by the manufacturer.

Fuel soot reaches the oil in excessive quantities if abnormal blowby occurs or even when blowby is normal, if combustion is late or incomplete. Liquid fuel dilutes the oil usually as a result of leaks in the injection system.

Water originates from leaky gaskets in the engine or oil cooler and also from condensation of blowby gases if crankcase temperature is too low or if crankcase ventilation is insufficient. Water is apt to displace the lubricant at points on rubbing surfaces causing the formation of small amounts of rust, which is abrasive. Water also does not separate readily from dirty oil but forms permanent emulsions which are responsible for the jelly-like sludge sometimes found coating engine surfaces.

Little trouble due to sludge formation occurs in railroad Diesels due to the maintenance of a proper oil operating temperature. The temperature is high enough to largely eliminate water sludge and yet is not too high to cause severe oxidation of the oil.

Of interest, in connection with the oil drain period determination, is the property of oils called "dispersion." Dispersion refers to the ability of an oil to keep fuel soot and other carbonaceous particles finely divided preventing their coagulation into larger particles. An oil having high dispersion properties holds the carbon in suspension in an almost colloidal state so that it passes through filters and is not removed by centrifuging. A high dispersion value is usually achieved by the use of additives in the oil.

It is generally conceded that some high speed automotive type Diesels require an oil having high dispersion characteristics to prevent clogging of the oil filters. The clogging of the oil filters is not particularly disadvantageous provided the operator cleans or replaces the filters as necessary. In those engines which contaminate the oil rather quickly the frequent attention which must be paid to the filters becomes burdensome and an oil having dispersion ability is welcomed by the operator.

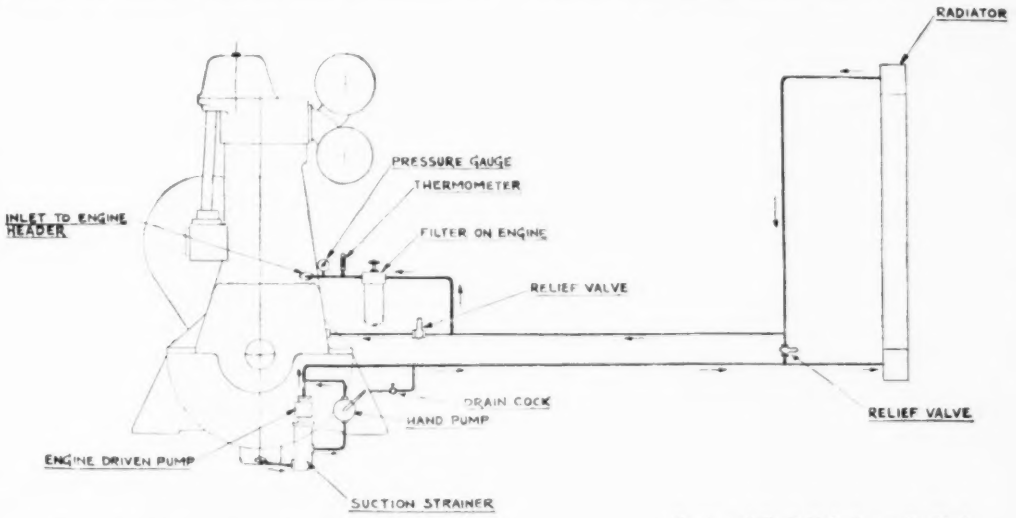


Fig. 8—Baldwin-De La Vergne Diesel Lubricating Oil system.

Courtesy of The Baldwin Locomotive Works

When such oils are used the carbon remains in the oil and must be removed from the engine by rather frequent oil drain periods.

On the other hand in a large stationary Diesel an oil with low dispersion characteristics is best suited since in such installations it is desired to use the oil for long periods without draining and an oil should be used which permits removal of carbon by filters and centrifuges.

Whether the railroad Diesel lubricant should or should not have dispersion characteristics is a somewhat controversial subject among lubrication engineers. If the majority opinion of the railroad Diesel maintenance engineers, as reflected by their choice of lubricants can be used as a guide, the use of a non-dispersion type oil is indicated. This preference for an oil of low dispersion power is based on a sound analysis of the problem. The railroad Diesel does not cause the formation of sufficient carbon in the oil to place a severe load on the filtering equipment; therefore, there is a natural desire to use an oil which will filter and reclaim readily and stay clean in service, thus lengthening oil life.

One advantage often overlooked when draining the oil is the opportunity to give the crankcase and oil tank a thorough cleaning, removing any settlings. The principal reason for changing the oil when it becomes contaminated

is of course to provide a constant supply of clean oil to all working parts. The usual oil drain period recommended by Diesel manufacturers is usually not over 3,000 hours for switching service and less for main line road service.

Oil Selection

It is difficult to conceive of a Diesel lubricant which will take care of the wide variety of conditions met in Diesel practice. The needs of one engine may be directly opposite to the requirements of some other Diesel. For example, one engine may need an oil which will hold carbon in suspension and form little deposit on filters while in another engine the oil should be of the type which will permit filters to remove carbon thus extending drain periods more or less indefinitely. Each oil has a most satisfactory operating range; one engine may need an oil which will operate best at a certain ring temperature while another engine requires an oil best suited for a different temperature. One engine may require an oil of high oiliness characteristics while in some other engine extreme oiliness may be a disadvantage, as has been the case in a recent model. It is, therefore, necessary to reconsider in brief the lubricating oil requirement of the railroad Diesel.

Summarizing, a lubricating oil for the railroad Diesel should perform the following functions efficiently:

(1) Maintain a tight seal between combustion chamber and crankcase by keeping rings free and unworn. In doing this the oil must: provide a film between the rings and the cylinder, not form gummy or hard decomposition products, wash away fuel deposits, and to varying degrees, act as a piston cooling medium.

(2) Prevent bearing difficulties by: maintaining a continuous film between the bearing surfaces; protecting bearing materials against corrosion and increasing bearing fatigue strength by carrying away heat.

(3) Keep the engine clean (including such parts as rings, pistons, cylinders, crankcase, valves, exhaust ports and oil coolers) by: remaining stable under reasonably high temperatures, not carbonizing on hot surfaces, not emulsifying with water and above all by filtering and reclaiming readily without appreciable deterioration in quality.

To take care of all types of Diesel service, stationary, marine, railroad, automotive and tractor, there are available four types of lubricants, straight naphthene mineral oils, straight paraffin mineral oils, naphthene oils plus additives and paraffin oils plus additives. It is just as true in lubrication as in any other type of engineering that the choice of materials depends upon the particular design and service conditions. A straight naphthene oil possesses the necessary characteristics to meet the present requirements, enumerated above, of the great majority of railroad Diesels.

It is true that some oils do not provide the easy starting characteristics of other oils; however, this is only a consideration where locomotives are exposed to low temperatures for long periods when not running. To prevent freezing of water in the cooling system, locomotive engine rooms are ordinarily maintained at temperatures sufficiently high to obviate any starting difficulties.

Occasionally certain installations require special qualities in a lubricant other than those listed at the beginning of this section. For such unusual cases one of the other types of lubricants may be better suited. Actually, nearly seventy percent of the Diesel horsepower in streamliners is being lubricated with a straight naphthene oil.

It is not only possible but highly probable that the lubrication requirements of the railroad Diesel will change as new designs are developed. Up to the present, however, additives have not proven particularly effective or advantageous in railroad Diesel lubricants.

If such oils are used investigation should be made to make sure that they:

(1) Do not corrode bearings.

(2) Will remain effective during the life of the oil.

(3) Will not be adversely affected by reclaiming.

(4) Do not react unfavorably when mixed with water.

(5) Permit the removal by filtration of fuel soot and other sludge and varnish forming constituents from the oil in service.

An S.A.E. 40 oil will generally have the proper viscosity for railroad Diesels. This grade of oil may be a little heavier than sometimes necessary; however, this provides for a certain amount of dilution, for occasional high temperatures and assists in reducing oil consumption. The same oil is ordinarily used for both bearings and cylinders.

Conclusion

The successful lubrication record being established by railroad Diesels is the result of the fine cooperative spirit existing between the manufacturer, the operator and the lubricating oil supplier.

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GENERAL RECOMMENDATIONS

TEXACO LUBRICANTS

FOR ROAD DIESEL LOCOMOTIVES

Engines	Ursa, Ursa MH or Ursa H
Engine Air Filter	Ursa Oils*
Governor—Engine	Ursa Oils*
Air Compressor	Ursa Oils*
Air Compressor Air Cleaner	Alcaid or Ursa Oils*
Air Compressor Crankcase Breather	Ursa Oils*
Throttle, Governor and Shutter Linkage	Starfak No. 3
Main Generator	Starfak No. 3
Auxiliary Generator	Starfak No. 3
Fuel Pump Motor	Starfak No. 3
Cab Heater Motor	Starfak No. 3
Headlight Dynamotor	Starfak No. 3
Traction Motor Armature Sleeve Bearing	748 Texayce Oil
Traction Motor Armature Roller Bearing	Starfak No. 3
Axle Bearings	748 Texayce Oil
Gear Case	Crater No. 2, 3, or 5
Journal Box (*Friction Type*)	748 Texayce Oil
Journal Box (*Roller Type*)	1559 RB Oil
Truck Center Bearing	748 Texayce Oil
Slack Adjuster	Starfak No. 3
Flexible Coupling	Marfak No. 3
Cooling Fans (*Well-Type*)	Stazon "C"
Cooling Fans (*Grease Packed*)	Starfak No. 3
Control Station	Alcaid or Ursa Oils*
Boiler Pump Motor	Starfak No. 3
Boiler Blower Bearing	Starfak No. 3
Power Switch—Reverser Air Engines	
Oil Cup	Ursa Oils*
Pressure Fittings	Starfak No. 3
Air Engine Leather	Neatsfoot Oil
Contacts	1231 Petrolatum
Boiler Rotary Converter	Starfak No. 3
Boiler Magneto Bearings	Starfak No. 3
Boiler Magneto Cam	Starfak No. 3
Windshield Wiper	Alcaid or Ursa Oils*
Boiler Water Pump	Dolphin
Door and Window Hardware	Alcaid or Ursa Oils*
Tachometer Drive	Stazon "C"
Hand Brake Wheel	Ursa Oils*
Shock Absorber Linkage	Brake Cyl. Lubr.
Windshield Defroster	Alcaid or Ursa Oils*
Brake Cylinder	Brake Cyl. Lubr.
Battery	Stazon "C"
"Grasshopper"	Ursa Oils *
Traction Motor Blower	Starfak No. 3
Fan Idler	Starfak No. 3
Fan Jackshafts	Starfak No. 3
Fan Jackshaft	Ursa Oils
Speedometer Generator	Starfak No. 3
Voltage Regulator	Alcaid Oil
Shutters	Ursa Oils* or Starfak No. 3
Flex. Coupling Pilot Bearing	Starfak No. 3
Diaphragm Centering Device	Starfak No. 3

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